Role of multislice computed tomography in scoring of coronary artery calcification

Essay
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Abstract

Background: Coronary calcium scoring by multi-slice CT (MSCT) is a recent technique used to diagnose coronary artery atherosclerosis and screening of asymptomatic individuals with risk factors of coronary artery disease and follow-up of patients who received treatment for coronary artery disease.

Objectives: To detect coronary artery calcification and its scoring using multi-slice CT as a non-invasive imaging modality.

Conclusion: Coronary artery calcium scoring is a promising tool for acquiring insight for coronary calcium present in the coronary arteries. Using electron beam tomography in the past and multi-slice computed tomography nowadays, calcium scoring can be performed within minutes. MSCT is a recent development in the spiral CT. However, MSCT offers a large scale of possibilities in data acquisition and reconstruction. The amount of coronary calcium is generally used as an indicator for risk assessment of patients with suspected coronary artery disease.

Key words: coronary artery disease (CAD)/ multi-slice computed tomography (MSCT)/ coronary calcium score (CCS).

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CONTENTS

Introduction

There is a correlation between the amount of calcium present in coronary arteries with the severity of coronary artery disease and thus the likelihood of a cardiac event **(Rydberg J et al, 2000)**.

Despite the availability of effective preventive therapies, cardiovascular disease remains a leading cause of morbidity and mortality. In addition to elevated lipoproteins and various coagulation and inflammatory factors, baseline levels of atherosclerotic disease assessed with noninvasive means also contribute to the risk of cardiovascular events **(Greenland P et al, 2000; Kullo IJ et al, 2000 & Ross R.N, 1999)**.

Coronary artery calcification (CAC) is a linear estimate of the total burden of coronary atherosclerosis that highly correlates with autopsy and intravascular ultrasound assessment **(Budoff MJ, 2003)**.

In fact, CAC provides a better estimate of burden of disease than luminal stenosis as determined by coronary angiography, since less-obstructive plaques actually give rise to more occlusions than more-obstructive plaques because of their greater number **(Sangiorgi G et al, 1998)**.

CAC detection by CT directly detects only hard or calcified plaque, but the calcification found essentially serves as a surrogate marker for soft or non-calcified plaque as well, since in the vast majority of patients both types of plaques coexist proportionally **(Schmermund A et al, 1998)**.

Coronary artery calcification is a marker for atherosclerotic lesions in the coronary arteries. The amount of coronary artery calcification is correlated to the risk of coronary events. However, absence of coronary artery calcification does not rule out atherosclerosis. Applications of quantitative assessment of coronary artery calcification are screening of asymptomatic individuals with risk factors for coronary artery disease and follow-up of patients who received medication for the treatment of coronary artery disease **(A de Roos et al, 2006)**.

Coronary artery calcification is well visualized with X-ray techniques such as radiography but only CT provides a non-invasive method for detecting and quantifying coronary artery calcification **(Girshman J et al, 2003)**.

The presence of artery calcification is specific to coronary artery disease (CAD) or coronary atherosclerosis though in some rare cases (e.g. hypervitaminosis D) is similar to classical atherosclerosis **(Becker, 2003)**. Measurement of coronary artery calcification is called calcium scoring (CS).

At present, there are various methods to examine coronary artery. However, there are only two most popular and non-invasive techniques applied to identify and quantify coronary calcification. These are electron beam computed tomography (EBCT) and multi-slice computed tomography (MSCT).

Dr. Agatston et al first introduce CS by using EBCT to detect coronary calcification. CS is determined on the basis of the product of the total area of a calcified plaque and an arbitrary scoring system for those pixels with attenuation greater than 130 Hounsfield units (HU) **(Marincek, Ros et al, 2001)**.

The application of MSCT for quantification of coronary calcium made it mandatory to switch to new quantification methods that can be compared for different scanners and that are robust with respect to different scanners and acquisition protocols. Alternatives for the Agatston score are the volume score (the volume of all voxels exceeding a certain threshold) and calcium mass **(Ulzheimer S et al, 2003)**.

Since the introduction of last generation MSCT systems and the development of simultaneous electrocardiographic-tracing image acquisition and retrospective reconstruction techniques into clinical routine, cardiac MSCT has been considered a very useful non-invasive technique for the study of cardiac pathology in the daily clinical practice. One of the main clinical applications of this diagnostic technique is the evaluation of the coronary arteries including detection and quantification of coronary calcium **(Bastarrika G et al, 2004)**.

Electron beam computed tomography (EBCT) revolutionized cardiac imaging by combining a constant high temporal resolution with prospective ECG triggering. For years, EBCT was the primary technique for some non-invasive diagnostic cardiac procedures such as calcium scoring and non-invasive-angiography of the coronary arteries.

Multi-slice spiral computed tomography (MSCT) on the other hand significantly advanced cardiac imaging through high volume coverage, improved spatial resolution and retrospective ECG gating. Due to isotropic sub-millimeter spatial resolution and retrospective data selection MSCT seems to be the non-invasive method of choice for cardiac imaging in general and for assessment of the coronary arteries in particular. However, technical developments are still needed to further improve the temporal resolution in MSCT and to reduce the substantial radiation exposure.

(Lembcke A, et al, 2006)

Aim of the work

The aim of this work is to show the role of multi-slice CT as a non-invasive diagnostic imaging tool in scoring and screening of coronary artery calcification.

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3D	Three-Dimensional
ABCA1	ATP binding cassette 1
ACE	Angiotensin converting enzyme
AGEs	Advanced glycation end-products
ATP	Adenosine triphosphate
CAC	Coronary artery calcification
CAD	Coronary artery disease
CHD	Coronary heart disease
CPR	Curved planar reformation
CT	Computed Tomography
CTA	Computed tomography angiography
EBCT	Electron beam computed tomography
GCV	Great cardiac vein
HDL	High-density lipoprotein
HU	Hounsfield unit
ICAM-1	Intercellular adhesion molecule 1
IL-1	Interleukin-1
LAD	Left anterior descending artery
LCA	Left coronary artery
LCX	Left circumflex artery
LDL	Low-density lipoprotein
MI	Myocardial infarction
MIP	Maximum intensity projection
MPR	Multiplanar reformation
MSCT	Multi-slice computed tomography
PAI-1	Plasminogine activator inhibitor
PDA	Posterior descending artery
RAGE	Receptor for AGE
RCA	Right coronary artery
SSD	Shaded surface display
TNF-α	Tumor necrosis factor alpha
VCAM-1	Vascular adhesion molecule 1
VR	Volume rendering
γ- IFN	Gamma interferon

Review of Literature